CLAIMS

1. A method of assessing the operation of a device under test (DUT) at high and microwave frequencies comprising using an antenna terminating in a tip or apex to acquire microwave electromagnetic field measurements in a near field region of a test point of the DUT comprising the steps of:-

   siting the antenna in a test position with its tip at a predetermined distance and at a predetermined inclination to the test point;

   energising the DUT; and

   measuring and recording a microwave property of the DUT.

2. A method as claimed in claim 1, comprising the additional steps of:-

   displacing the antenna along its axis to site the antenna at another test position a predetermined distance and at substantially the same inclination to the test point;

   measuring and recording the microwave property; and

   calculating and recording the difference in the microwave properties to provide information about the operation of the DUT.

3. A method as claimed in claim 2, in which the antenna is displaced a distance between 1 μm and 50 μm.

4. A method as claimed in any preceding claim, in which the inclination of the antenna is substantially orthogonal to the DUT.

5. A method as claimed in any of claims 1 or 3, in which the antenna is sited at an inclination to the vertical and the method comprises the additional steps of:-

rotating the antenna about its apex by a predetermined rotation angle, while maintaining its inclination to the vertical;

measuring and recording the microwave property;

calculating and recording the difference in the microwave properties to provide information about the operation of the DUT.

6. A method as claimed in claim 5, in which the predetermined rotation angle is substantially 180°.

7. A method as claimed in claim 5, in which the antenna is rotated at rotation angles of substantially 120° and 240° to obtain three sets of measurements.

8. A method as claimed in any of claims 5 to 7, in which the inclination to the vertical is substantially 45°.

9. A method as claimed in any preceding claim, in which the sensitivity of measurement of the electrical field intensity at a particular frequency is defined by

$$S = \frac{\Delta U}{E_l \Delta l}$$

where:

ΔU is the voltage difference of antenna signal measured for two positions of the antenna displaced along antenna axis;

Δl is the displacement of the test positions;

E_l is the component of the electrical field intensity of the microwave field parallel to the antenna axis; and

S is a sensitivity constant

and in which

the sensitivity constant (S) is determined by a calibration measurement in a well defined field standard and is subsequently used to determine the real value of the electrical field intensity of a DUT during a test.

10. A method as claimed in any preceding claim, in which the microwave property of the DUT is one of the amplitude, phase or frequency of the voltage detected by the antenna.

11. A method as claimed in any preceding claim, in which the test position is chosen to minimise the capacitive and inductive couplings between the antenna and the DUT while providing a sufficiently strong signal.

12. A method as claimed in claim 11, in which the test position is at least spaced-apart from the DUT by a distance greater than the widest lineal dimension of the tip of the antenna facing the DUT.

13. A method as claimed in claim 11, in which the separation between the tip of the antenna and the test point of the DUT is between 1 μm and 100 μm.

14. A method as claimed in any preceding claim, in which the frequency range of operation is between 50 MHz and 50 GHz.

15. A method as claimed in any of claims 1 to 13, in which the frequency range of operation is between 300 MHz and 30 GHz.

16. A method as claimed in any preceding claim, in which the siting of the antenna comprises:-

moving a topography probe, attached to a quartz crystal oscillator to a probe position adjacent the DUT;

fixing and recording the probe position;

measuring the offset distance between the probe and the antenna apex using a separate offset distance measuring device; and

positioning the antenna apex above the same point of the DUT by taking into account the offset distance and displacing the antenna by an additional distance along the antenna axis.

17. A method as claimed in claim 16, in which the topography sensing system comprises an excitation generator to operate at the resonance frequency of the probe and means to extract the oscillation response signal of the probe from that of the excitation signal based on the orthogonality of the phases of those signals and hence a measure of the distance of the probe from the DUT.

18. A method as claimed in claim 16 or 17, in which in order to measure the offset distance the topography probe is brought into a focus point of a long focal length microscope and the antenna are brought to the same focus point to measure the offset between the positions of the probes.

19. A method as claimed in any of claims 16 to 18, in which the test position is recorded relative to a datum point of a fixture for reception of the DUT and this test position is used for subsequent similar DUTs placed on the fixture.

20. A method as claimed in claim 19, in which the test position for a number of similar DUTs is recorded, averaged and used to provide the test position for subsequent similar DUTs.

21. A method as claimed in any preceding claim, in which a plurality of DUTs which have been determined to function correctly in practice are measured at

one or more test points and the resultant measurements recorded as acceptable measurements for subsequent DUTs measured at these test points.

22. An antenna (3) for use in the method of any preceding claim, comprising a coaxial shielding (7) and a protruding conductor (8) therefrom in which the length by which the conductor protrudes from its shielding (7) substantially exceeds the greatest lineal dimension (D) of the shielding (7) adjacent the conductor (8) to isolate the effects of the shielding (7) from the DUT (2).

~~23. An antenna (3) as claimed in claim 22, in which the antenna is a coaxial~~ antenna (3) and in which the length (l) by which the conductor (8) protrudes exceeds, by at least a factor of two, the external diameter (D) of its coaxial shielding (7) and by at least the same factor, the smallest dimension (w) of the feature at the DUT that needs to be resolved.

24. An antenna (3) as claimed in claim 23, in which the factor is at least three.

25. A topography sensing system (15) for use in the method of claims 1 to 21 comprising:-

a quartz crystal oscillator (16);

a topography probe (17) connected to the oscillator (16);

an excitation generator (18) having means to operate at the resonance frequency of the oscillator (16) with the probe (17); and

means to shift the phase of the oscillation frequency of the probe (17) from that of the oscillation signal and to extract the oscillation signal as a measure of the distance between the probe (17) and the topography.

26. A topography sensing system (60) for determining the vertical height above a

DUT in the method as claimed in any of claims 1 to 21 comprising:-

a holder (62);

control means for moving the holder vertically with respect to the topography;

a probe (61) being supported in the holder (62) in a rest position and freely movable upwards within the holder (62) on the tip (72) of the probe (61) contacting portion of the DUT (2);

means to record displacement of the probe (61) on contact being made to measure the distance of the holder (62) from the portion of the DUT (2) with which contact was made.

27. A sensing system (60) as claimed in claim 26, in which the holder (62) comprises a bored tube and the probe (61) is a stiff rod mounted within the tube.